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Invention Report No. 30-20

IGNITION SYSTEM FOR MONOPROPELLANT COMBUSTION DEVICES

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JET PROPULSION LABORATORY
California Institute of Technology
Pasadena, California
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INVENTION RECORD

To be submitted to Invention Reports Group

Jet Propulsion Laboratory
California Institute of Technology

1. Inventor name	position & title	P O address and legal residence
John J. Chilenski	Research Engineer	1107 W. Delhaven Avenue West Covina, California

2. Title of Invention Ignition System for Monopropellant Combustion Devices

3. Brief Description and Novel Features My invention relates to a simple, light-weight and reliable, blow-down system for initiating combustion in m. p. devices . This system consists of a pre-pressurized oxidizer cartridge and fire valve mounted directly on the injector. The cartridge is charged by loading a predetermined amount of nitrogen tetroxide into the tube, capping and pressurizing through a check valve with high pressure nitrogen gas, thus trapping the gas in the loaded cartridge. Energizing the firing valve opens both circuits, allowing the fuel to enter from its regulated source and the oxidizer cartridge to blowdown, injecting the slug of oxidizer into the chamber in the process. The propellants are hypergolic, combustion is obtained and the decomposition of the monopropellant is sustained. This ignition system is adaptable to any combination of hypergolic propellants. This system requires no mechanical moving parts such as pistons, etc.

4. Historical Data	date	location
a. conception by inventor	Aug., 1958	J.P.L.
b. disclosure to others	Aug., 1958	J.P.L.
c. first sketch or drawing	Aug., 1958	J.P.L.
d. first written description	Oct., 1958	J.P.L.
e. completion of model or full-sized device	Sept., 1958	J.P.L.
f. first test or operation of invention	Sept., 1958	J.P.L.

5. Names of Persons Acquainted With Items 4 thru 7

Don Lee Don Lee 9-21-59

David D. Evans David D. Evans 9-21-59

D. R. Bartz D R Bartz 9/21/59

6. Results of Test Over 100 satisfactory tests have been conducted to date. 10 vacuum ignition tests were conducted and 15 1-negative G tests conducted.

7. Applications and State of Development Being used in gas generator pumping system for Vega. - To be used in velocity control motor on Vega Zero-G start requirement.

8. Reference Reports, Publications and Drawings
C.B.S. #68, R.S. #1 and will be in R.S. #5.

9. Patents

10. Licenses

11. Contract No.
NASw-6

12. Signatures -- give signature and date, first names in full

a. witnesses

Subscribed and sworn to before me this 21 day of Sept 1959

[illegible] Notary Public
In and for the County of Los Angeles, State of California

My Commission Expires May 17, 1963

b. inventors

John Joseph Chilenski
John Joseph Chilenski 9/21/59

IGNITION SYSTEM FOR MONOPROPELLANT COMBUSTION DEVICES

My invention relates to a simple, lightweight and reliable blowdown system for instantaneously initiating combustion in monopropellant decomposition devices. The invention disclosed herein comprises both a method and a means for accomplishing the desired results. Briefly, the system consists of a prepressurized oxidizer cartridge, a firing valve and an injector, all of which are mounted in the wall of the decomposition chamber near the place where the monopropellant is injected into the catalyst bed. The cartridge is charged by loading a predetermined amount of nitrogen tetroxide or other such oxidizer into the tube, capping and pressurizing through a check valve with high pressure nitrogen gas. Energizing the firing valves opens both the fuel and oxidizer circuits, allowing fuel to enter from its regular source and the oxidizer to enter from the ignition cartridge, injecting the slug of oxidizer into the catalyst chamber in the process. The propellants are hypergolic, combustion is obtained and the decomposition of monopropellant is sustained. This ignition system is adaptable to any combination of hypergolic propellants. The system requires no mechanical moving parts.

In the past, several different methods for igniting and sustaining the decomposition of monopropellants such as hydrazine has been studied by several different groups, but the desired effect of having an instant ignition of such gas generators has presented somewhat of a problem. Formerly, one of the more successful methods for ignition of the catalyst bed has been to heat the bed electrically which of course necessitated a certain period of time before ignition could be initiated. Although this period was reduced to something less than a minute in some of the better designs, the time element involved still presented a problem and further, the necessity of having power available also made the system undesirable for flight gear.

In considering the use of my invention in space or in a vacuum, a somewhat different configuration is used in the blowdown mechanism. The unit as used under ordinary gravitational environment relies upon proper orientation force of gravity to keep the liquid oxidizer at the exit end of the cartridge. Energizing the firing valve allows the cartridge to blow down, thus injecting the slug of oxidizer into the chamber in the process. But, on the other hand, if this starting mechanism is to be used for combustion devices out in space, such as verniers, velocity control motors, and retrorockets, it is evident that a zero gravity ignition capability for such unit will be a major requirement. Thus, a zero gravity blowdown ignition cartridge must be used. Therefore, the objects of my invention are: first, to provide a simple lightweight instantaneous ignition system for monopropellant combustion chambers which is free of all moving mechanical parts as well as any outside power source. A second object of my invention is to provide a bi-propellant ignition system which provides instantaneous ignition of a catalyst bed under normal atmospheric conditions. A third object of my invention is to provide a means for instantaneously igniting a monopropellant catalyst bed under environments such as are expected out in space.

A more detailed explanation of my invention is provided in the description of the figures wherein Figure 1 is a schematic of a simple vernier motor.

Figure 2 is a partial cross sectional view of the cartridge used for space ignition.

A cylindrical thrust chamber 1 is provided on one end with an exhaust nozzle 2 and on the other end with a dome 3. The dome is provided with two inlets 4 and 5. Atomizing spray jets 6 and 7 are disposed in the inlets 4 and 5. The spray jet 7 is interconnected to the ignition cartridge 8 by a fuel line 9 through the firing valve 10. The cartridge 8 is a cylindrical member provided with a charging valve 11 which is a conventional check valve and cap. A selected amount of oxidizer 12 covers the exit to the firing valve. The recess 13 above the level of the oxidizer in the cartridge contains high pressure gas. The spray jet 6 interconnects to the monopropellant tank by a fuel line 14 through the firing valve 15. The monopropellant tank 16 is pressurized by a nitrogen source 17 through a pressure regulator 18. A catalyst bed 19 is disposed centrally in the cylindrical member 1 and is held in place by screens 20 and 21.

Reference is now directed to Figure 2. A zero gravity ignition cartridge comprises a gas reservoir 23, a gas charging valve 24, and a gas outlet 25, covered by an aluminum burst diaphragm 26. A tube 27 connected to the gas outlet on the downstream side of the burst diaphragm 26 serves as an oxidizer reservoir. A firing valve 28 closes off the line 27 from the atomizing spray jet 29. An inter-manifold pinch tube 30 interconnects the air gas reservoir 23 to the oxidizer reservoir 27.

This whole unit as shown in Figure 2 would replace the ignition cartridge as shown in Figure 1 when the gas generator was to be used in zero gravity environments.

OPERATION

These gas generators would be ignited in exactly the same manner generally by spraying oxidizer from the ignition cartridge into the catalyst bed along with the monopropellant, causing a hypergolic action which instantly ignites the catalyst bed and the decomposition of the monopropellant is sustained. In gravitational conditions, the less elaborate ignition cartridge shown in Figure 1 would normally be used.

In zero gravity ignition conditions, the configuration shown in Figure 2 would necessarily have to be used. In using this cartridge, the oxidizer would be placed in the tube 27 with the firing valve 28 closed and the cartridge would be charged with nitrogen through the charging valve 24. The inter-manifold pinch tube 30 would assure equalized pressure on both sides of the aluminum burst diaphragm 26. When the gas reservoir was charged to a desirable pressure, the pinch tube would be pinched off so that when the firing valve was open relieving the pressure on the downstream side of the burst diaphragm, the high pressure in the gas reservoir would burst the burst diaphragm 26 forcing the oxidizer out through the spray nozzle into the catalyst chamber. It might be supposed in the operation of this gas generator that damage could easily be done to the catalyst bed if the valve timing was not just right. Several tests have been made and it has been determined that it is evident that valve timing is not critical since a range from 200 milliseconds oxidizer lead to 200 milliseconds fuel lead was covered without damage to the catalyst bed. Dispite these successful firings, it is recommended that the valve timing be engineered so as to have simultaneous or a small oxidizer lead in their openings. This ignition system was tested on a small decomposition chamber with a nominal hydrozine flow rate of 0.085 pounds per second and a chamber pressure of 400 psia. The unit consisted of a 90° conical head injector having a 40 gph, 60° hollow cone, fuel jet mounted axially and a 3 gph, 60° hollow cone, oxidizer jet impinging from the side, a 2.00 outside diameter by .065 wall by 8 inch long stainless steel chamber and a nozzle plate. A total of 40 tests were conducted utilizing a blowdown oxidizer cartridge having a total volume of 16 cc's. The duration of the transient bi-propellant operation was varied by changing the quantity of oxidizer charged into the cartridge and the charging pressure. Tests were conducted to determine the range of quantity of oxidizer required for satisfactory ignition. This range was determined to be from 2 to 8 cc's of N2O4 pressurized to 600 psia. Tests below this range were not conducted due to the difficulty in loading such small amounts of oxidizer, whereas tests above this range resulted in damage to the catalyst bed. The valve timing should be such as to obtain from 100 to 200 millisecond oxidizer lead.

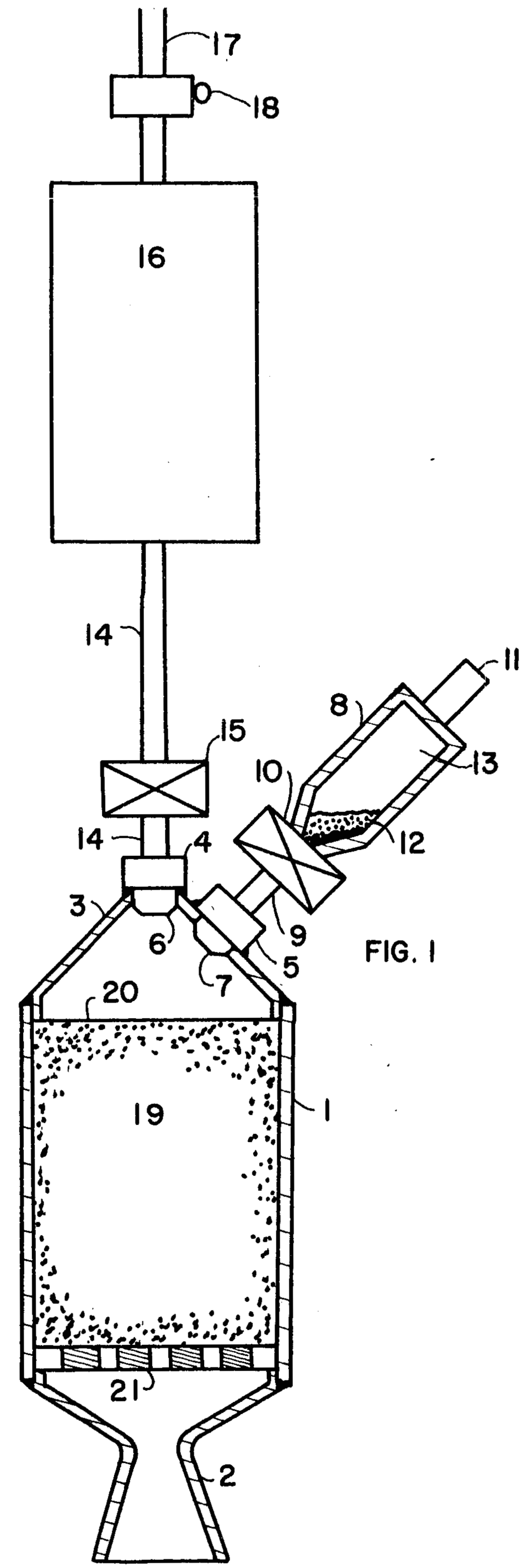

FIG. 1

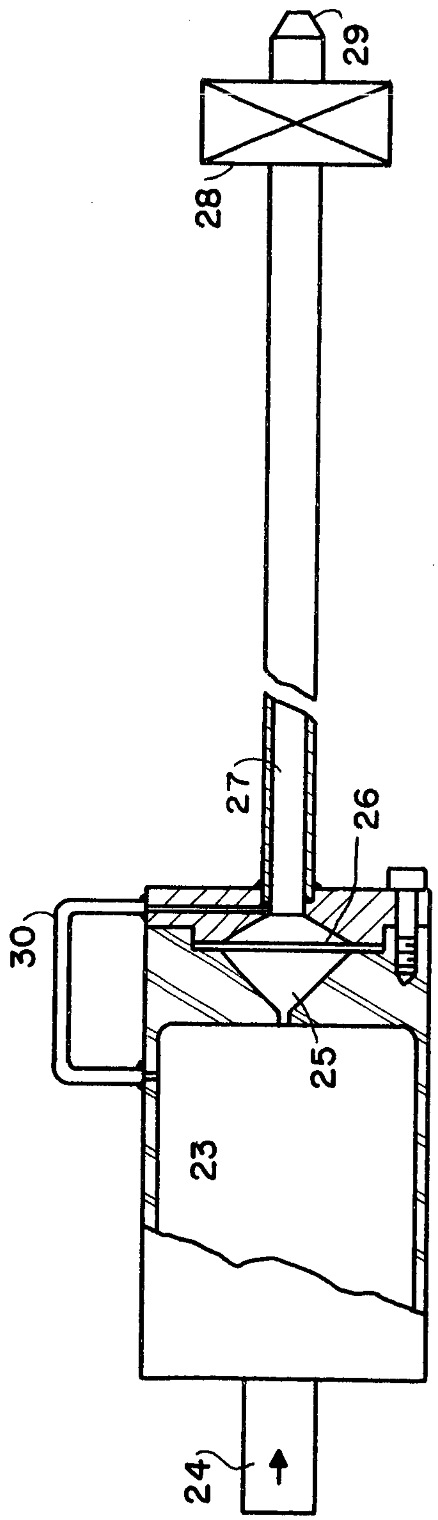

FIG. 2